**RSNA/QIBA: Variability Sources and Potential Mitigation Strategies in Shear Wave Elastography for the Staging of Liver Fibrosis**

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**OVERVIEW**

The Quantitative Imaging and Biomarkers Alliance (QIBA), comprising researchers, clinicians, imaging system manufacturers and representatives from the federal government (FDA, NIH, NIST) was established in 2008. The mission is to “improve the value and practicality of quantitative imaging biomarkers by reducing variability across devices, patients and times.” The QIBA Ultrasound Technical Committee has focused on mitigating variability in shear wave elastography for liver fibrosis staging.

Shear wave elastography has proven promise for the evaluation of intermediate stages of liver fibrosis (Samir 2012, Ferrari 2012, Palmer 2011). There is, however, multiple potential sources of variability, disease factors, patient-related dependency, and imaging system variation. Measurement variability is evident in differing shear wave speed values observed in different studies for similar stages of liver fibrosis.

**SOURCEs OF VARIABILITY**

**A. TECHNICAL SOURCES OF VARIABILITY**

- **Variability as a function of technology**
- **Variability as a function of measurement depth**
- **Variability as a function of probe type**
- **Variability as a function of shear wave frequency**

**B. IMAGING TECHNIQUE AND PATIENT-RELATED**

- **Fasting/Meals**
- **Body mass index (BMI)**
- **Patient position**
- **Patient breathing**
- **Liver lobe**

**C. CLINICAL CONFOUNDERS**

- **Steatosis**
- **Inflammation**
- **Autoimmune Hepatitis**
- **Right heart insufficiency**
- **Cholestasis**

**REFERENCES**


**Supporting Information**

Figure 1: Box and whisker plots showing the range of SWE values recorded in different studies for similar stages of liver fibrosis

**SUMMARY OF CLINICAL STUDY (PHASE 2 OF QIBA)**

- **For patients of 1 year September 2013–September 2014: 252 subjects were enrolled in a clinical study managed by the General Hospital London (UK) and the Heilbron University Hospital (Germany).**
- **All patients underwent 11 SWE measurements prior to liver biopsy (3×, 1×, 1×, 1×, 1×, 1×, 1×, 1×, 1×, 1×, 1×).**
- **Current quality control is available for 126 of these cases.**
- **A detailed data analysis will be completed in the coming few months.**

**TECHNICAL SOURCES OF VARIABILITY**

- **Shear wave frequency content (carrier frequency and bandwidth) can be variable (=10-50 kHz) and is dependent on ARFI focal probe configuration and excitation duration.**
- **Soft tissue viscoelasticity makes the reconstructed shear wave speed dependent on the shear wave filter.**
- **Assumptions in wave propagation direction to perform time-of-flight estimates can be violated:**
  - Depth dependences due to off-axis excitation sources (Zhou 2011)
  - Wave frequency content

**CLINICAL SOURNFIDERS**

- **Patient-related effects:**
  - Fasting/Meals
  - Body mass index (BMI)
  - Patient position
  - Patient breathing
  - Liver lobe

**ACCOMPANYING EDGINGS AND PARTICIPATING SITES**

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**DIGITAL PHANTOMS**

A first element simulation code of elastic and viscoelastic materials has been posted on GitHub: https://github.com/RSNA-QIBA-US-SWS/phantom

**CONCLUSIONS**

- **Determine c0, dc/df from max sum**
- **Use -12 dB upper bandwidth**
- **Develop a Case Report Form, to simplify data aggregation and reporting of clinical confounders**
- **Clinical study using different systems on the same patients to understand sources of bias**
- **Imaging Techniques and Patient Related Factors**
  - **UPK Guidelines for clinical trials**

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